

# A Conceptual Model of Flow and Sediment Transport in the Upper Yuba River Watershed

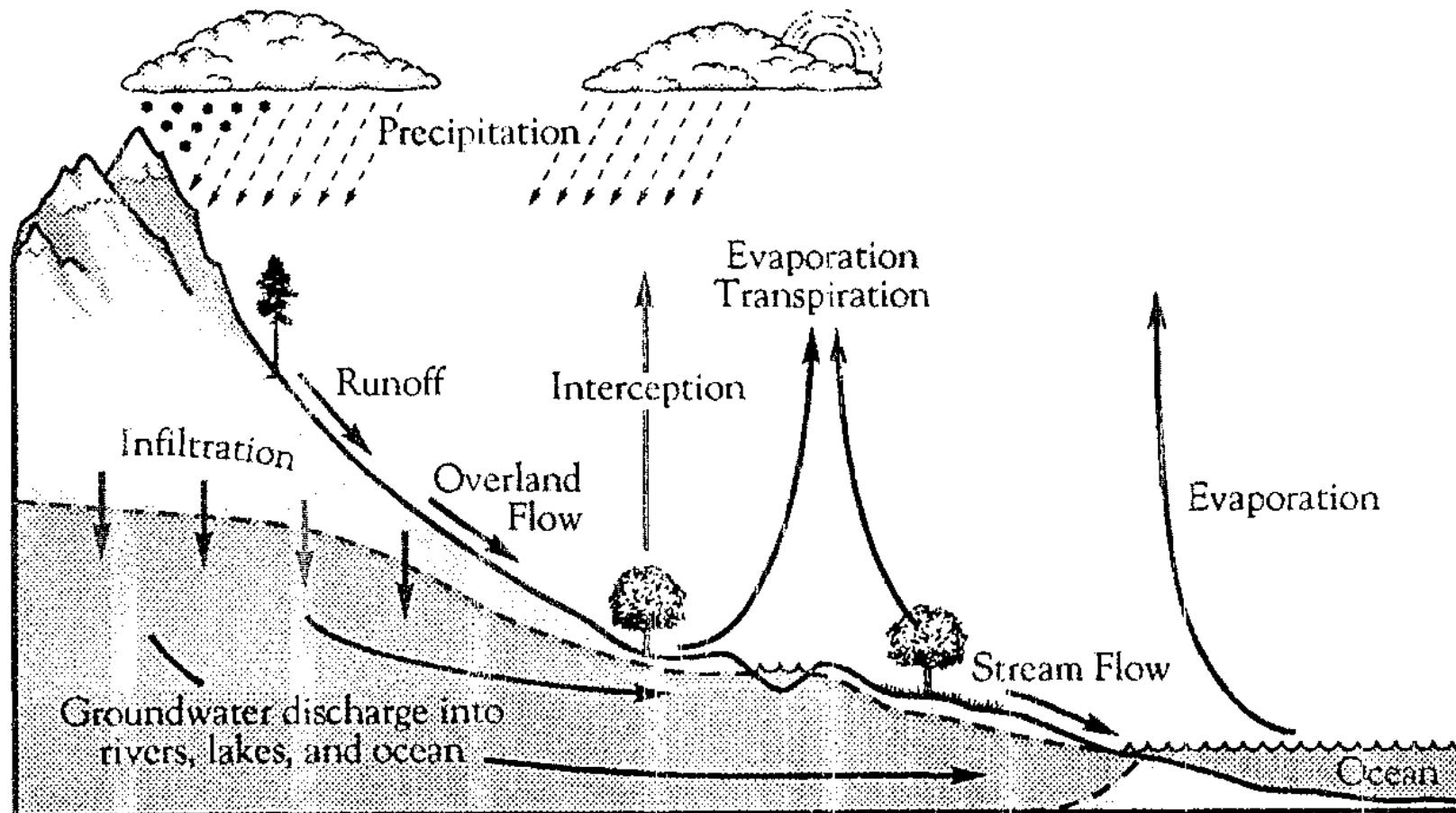
Upper Yuba River Studies Program  
USGS Sediment Studies



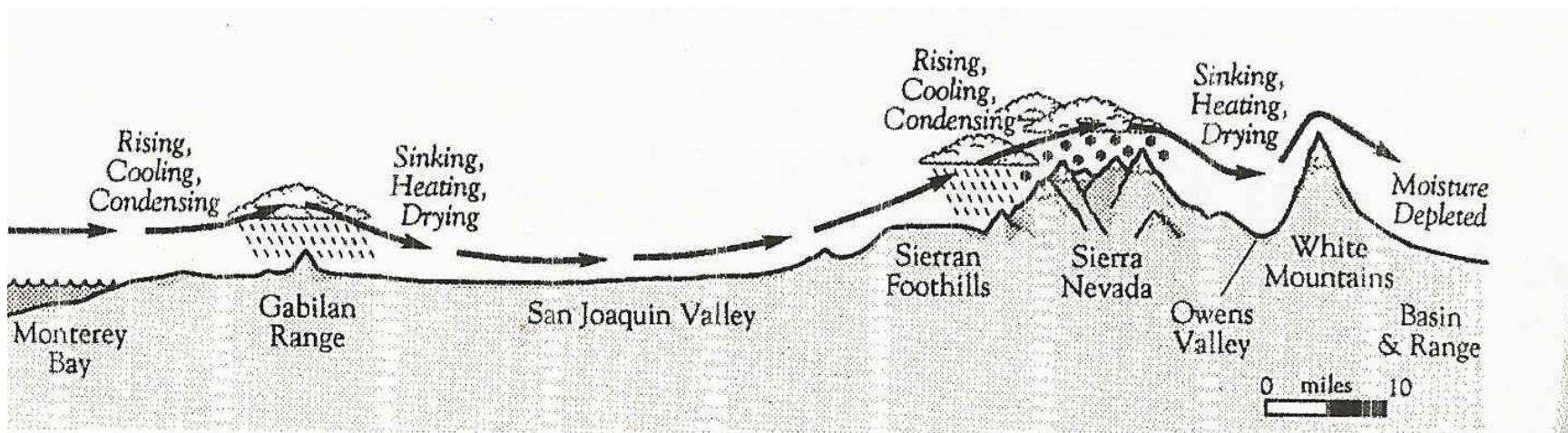
# The Yuba River Watershed

- A Sierra Nevada river originating in high country with winter snow covered mountains, extending to the great Central Valley
- Factors dominating the hydrology of this watershed
  - Precipitation: amount, timing, intensity
  - Geology and soils: permeability, erosivity
  - Energy loads: radiation, temperature
  - Vegetation: evapotranspiration, cover, interception

# Sierran Hydrologic Cycle

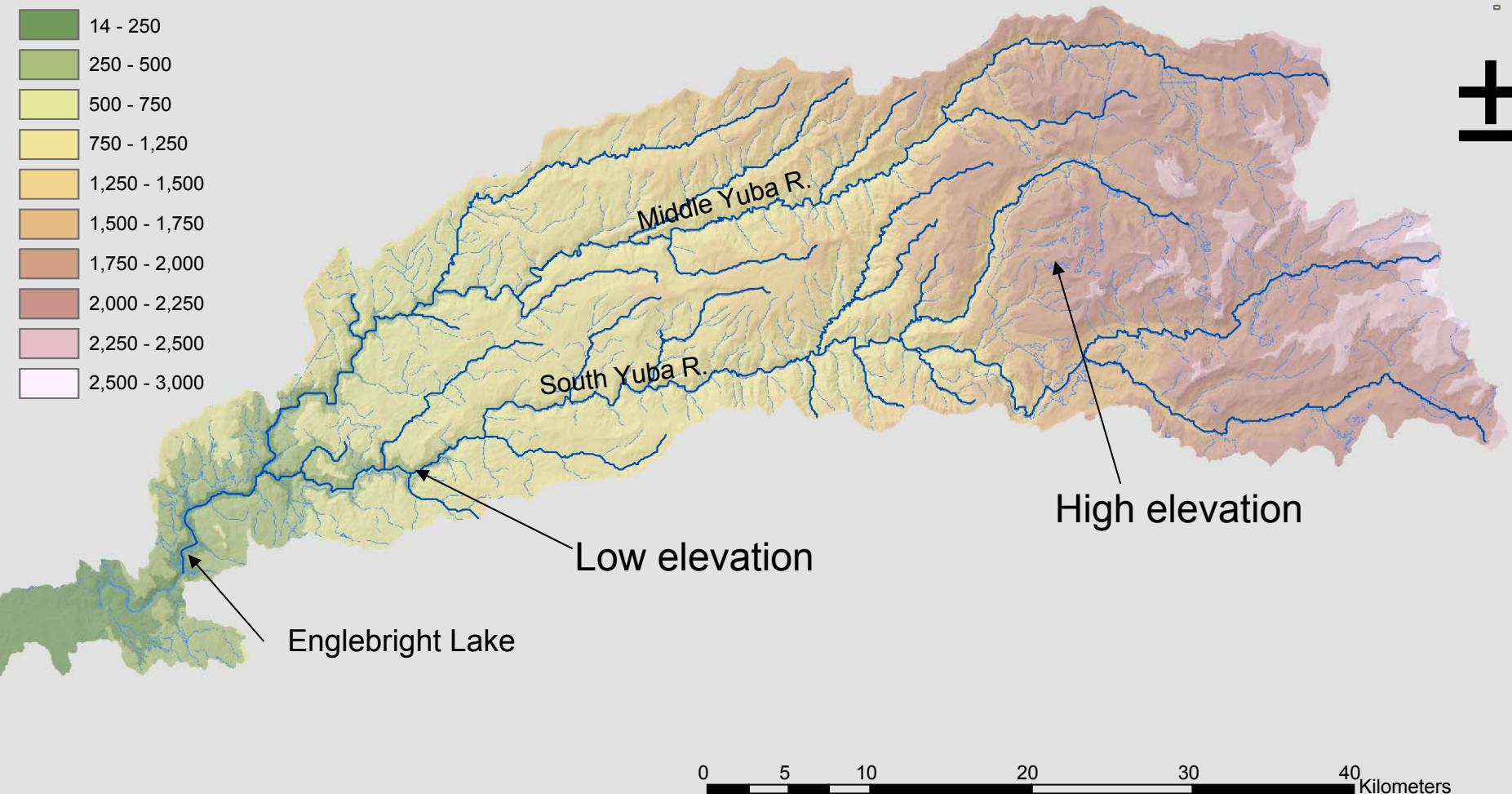


# California Precipitation



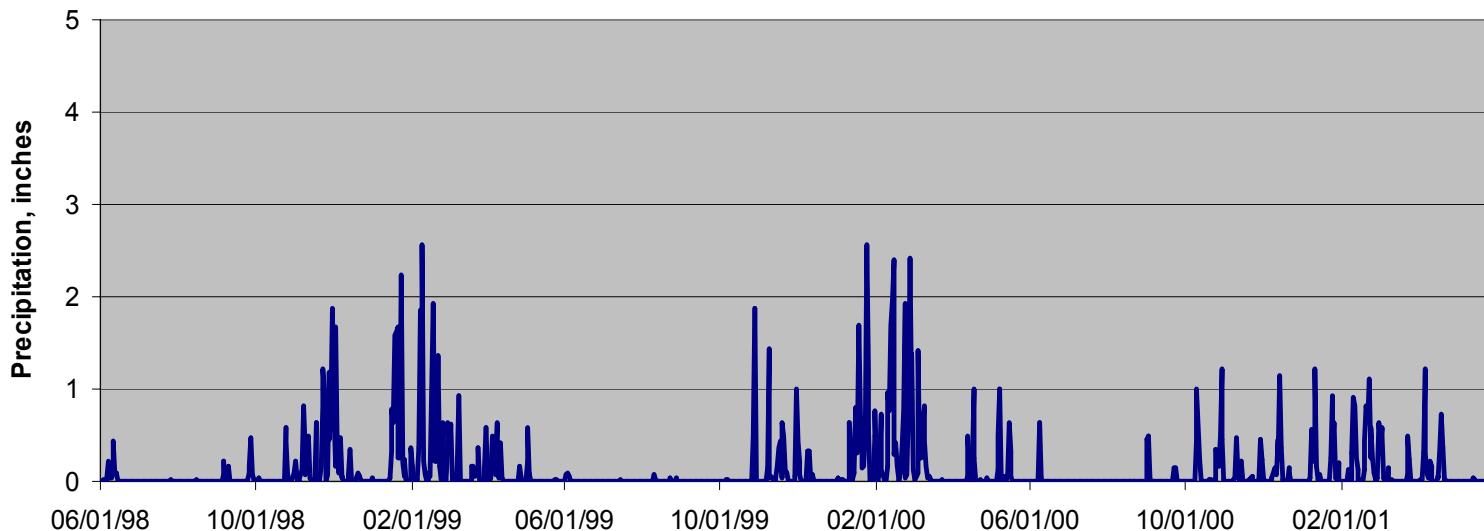
# Upper Yuba River Watershed

Elevation, m

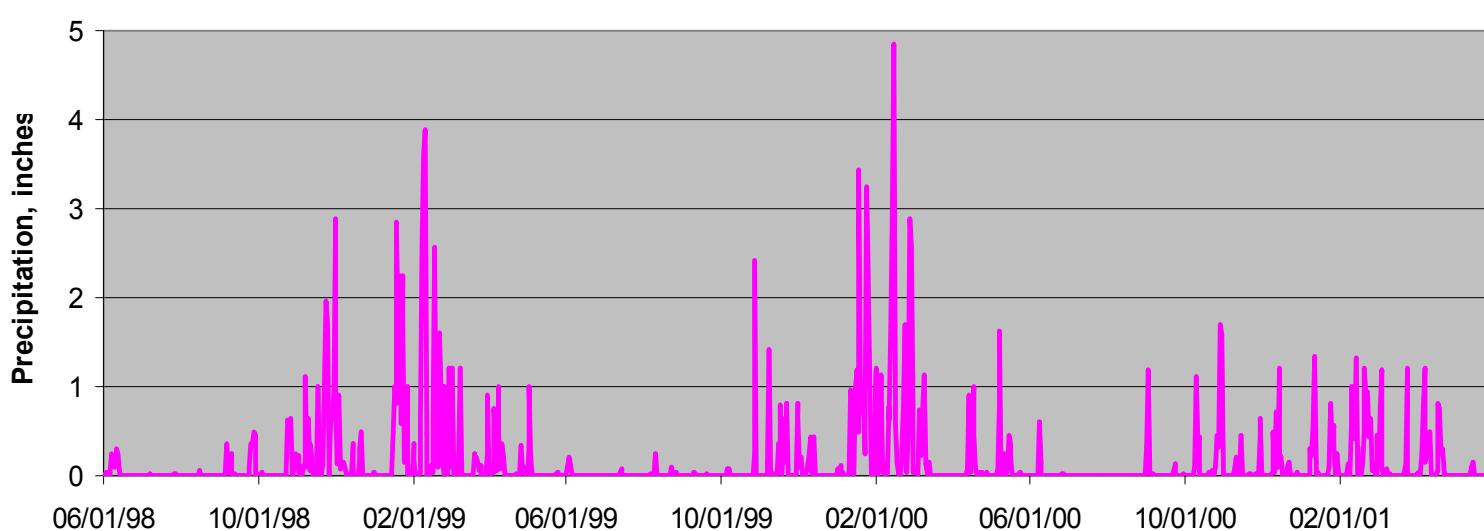


# Daily Precipitation at Low and High Elevations

Jones Bar low elevation

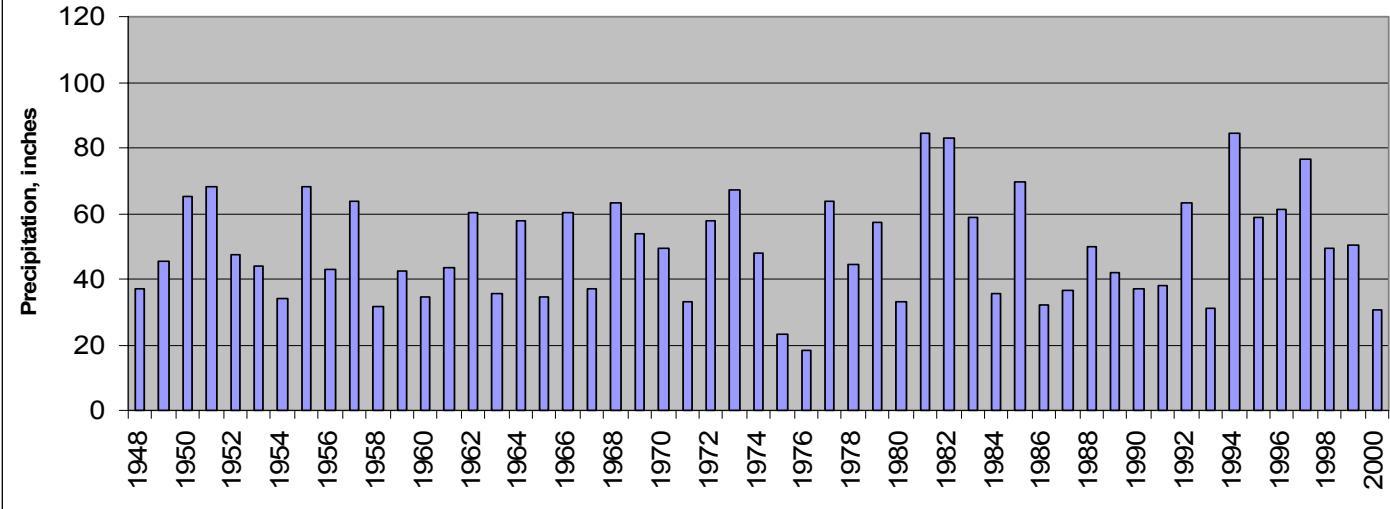


High elevation

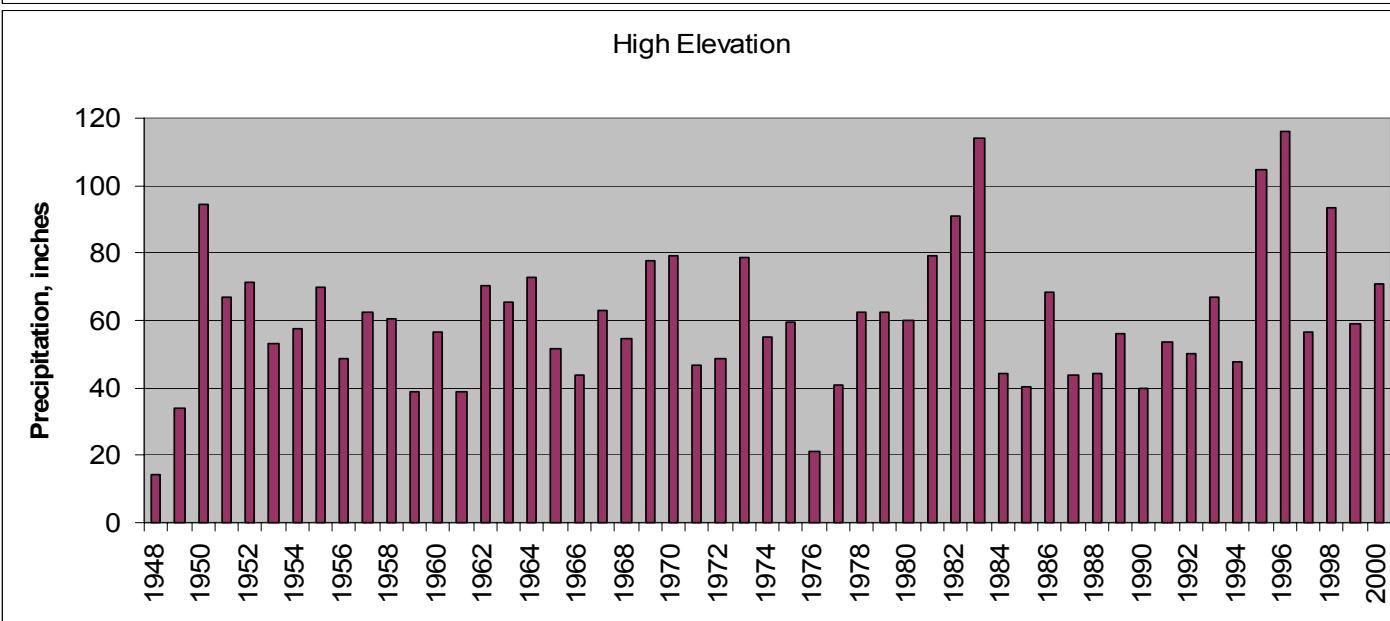


# Yearly Precipitation at Low and High Elevations

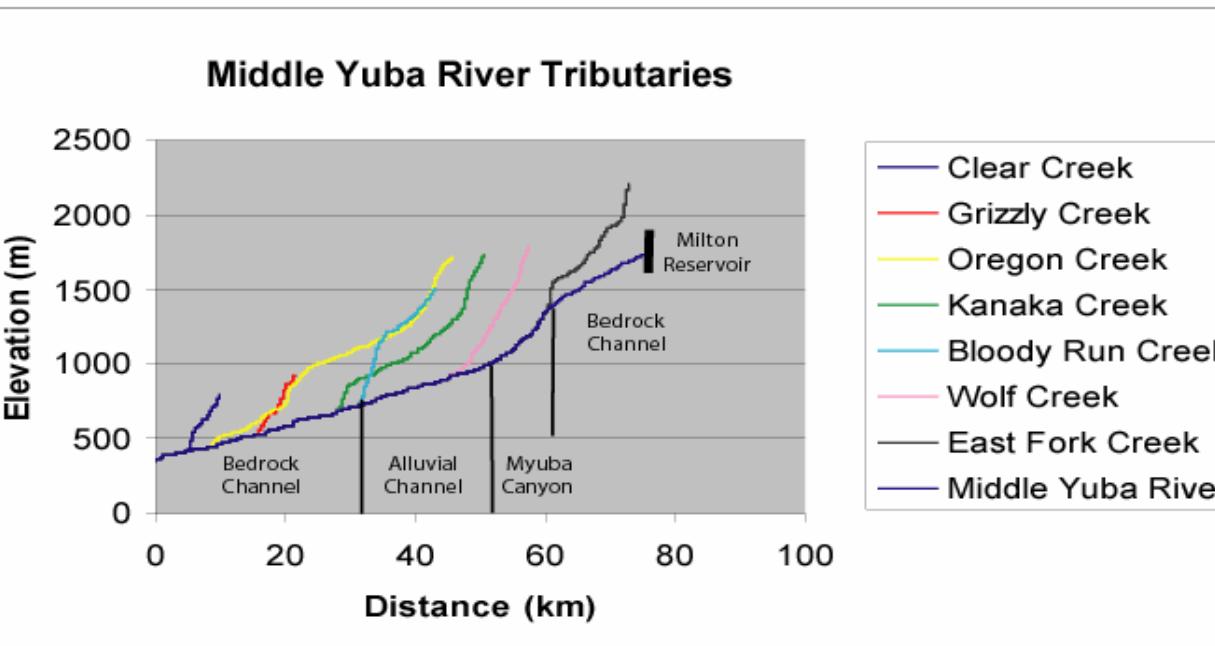
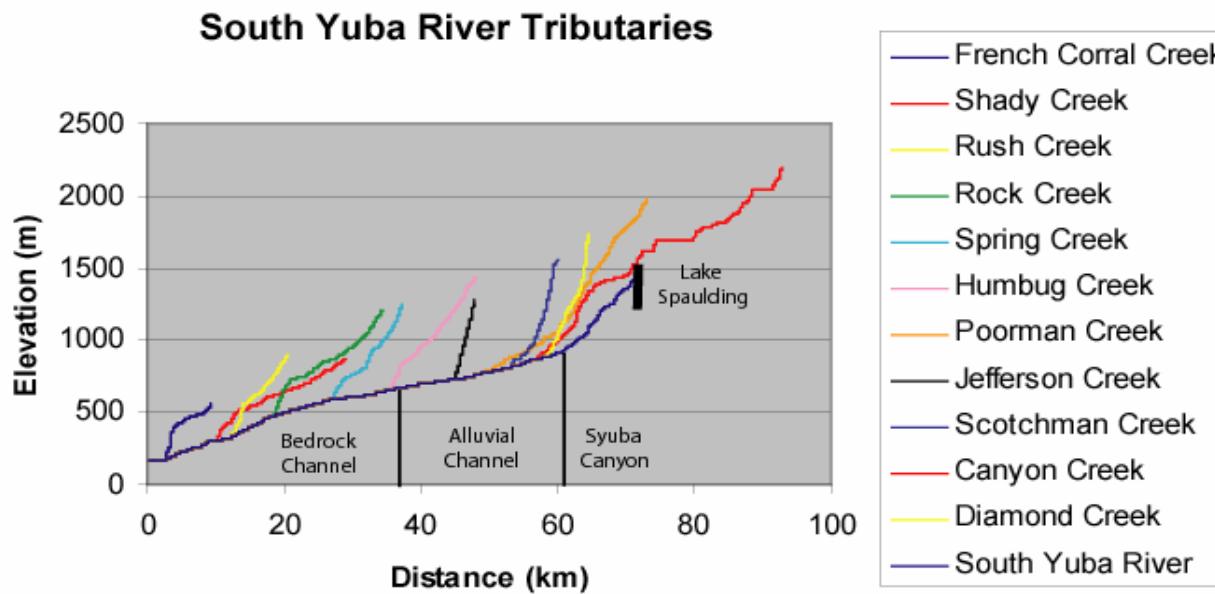
Low Elevation - Jones Bar



High Elevation

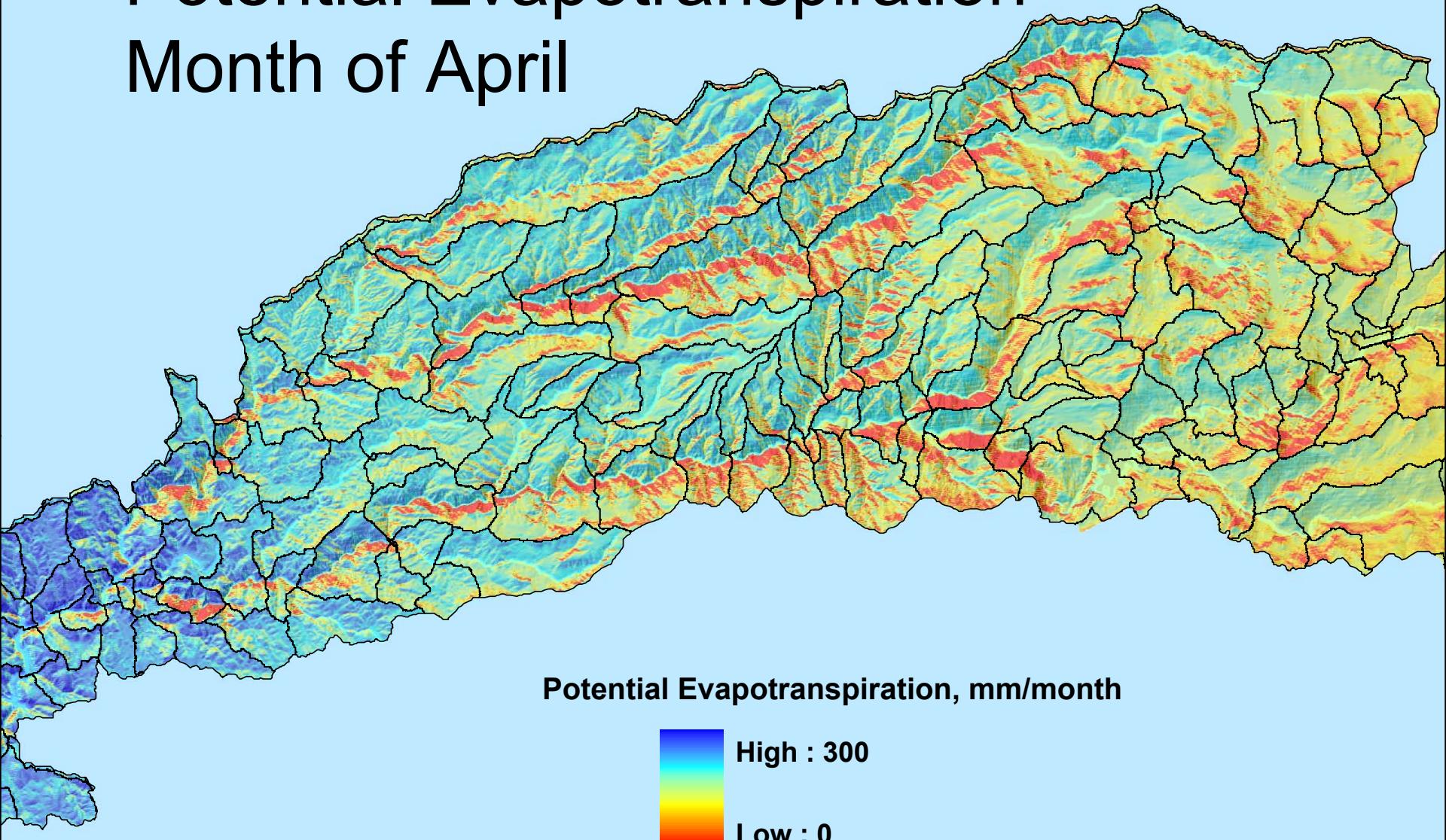


# Longitudinal Profiles of Upper Yuba Tributaries



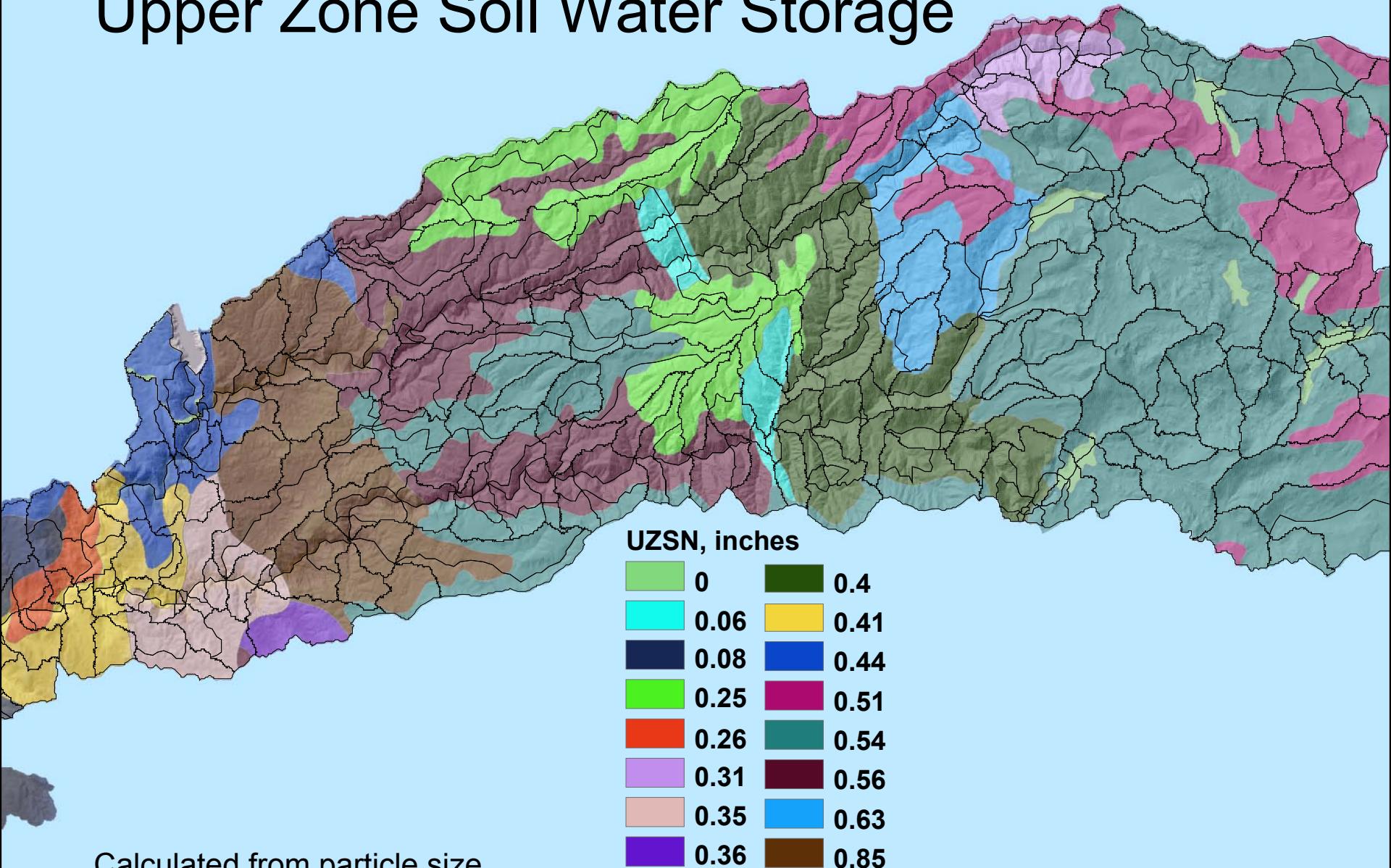
# Potential Evapotranspiration

## Month of April



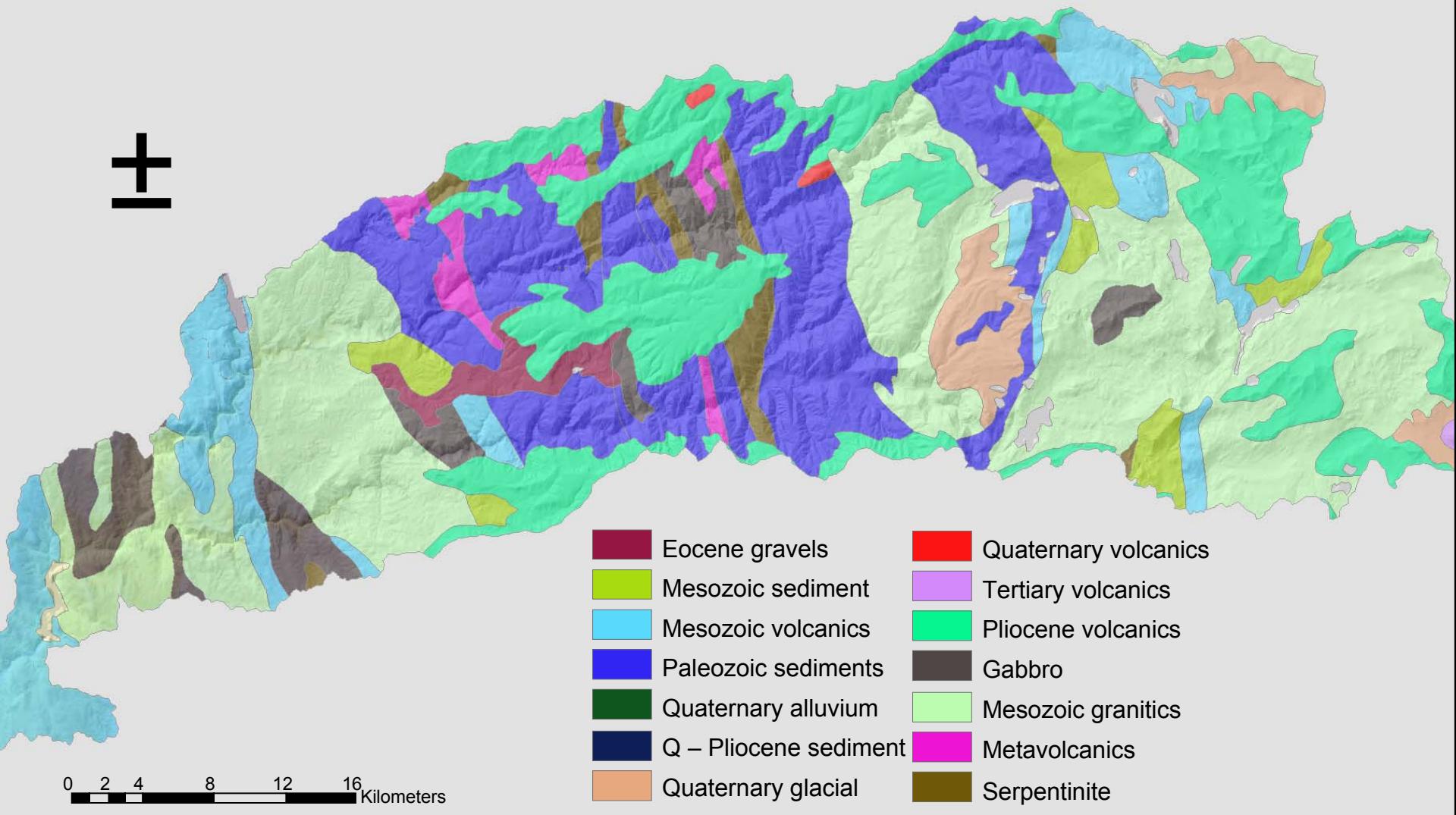
Modeled from radiation load  
From Flint and Childs, 1994

# Upper Zone Soil Water Storage



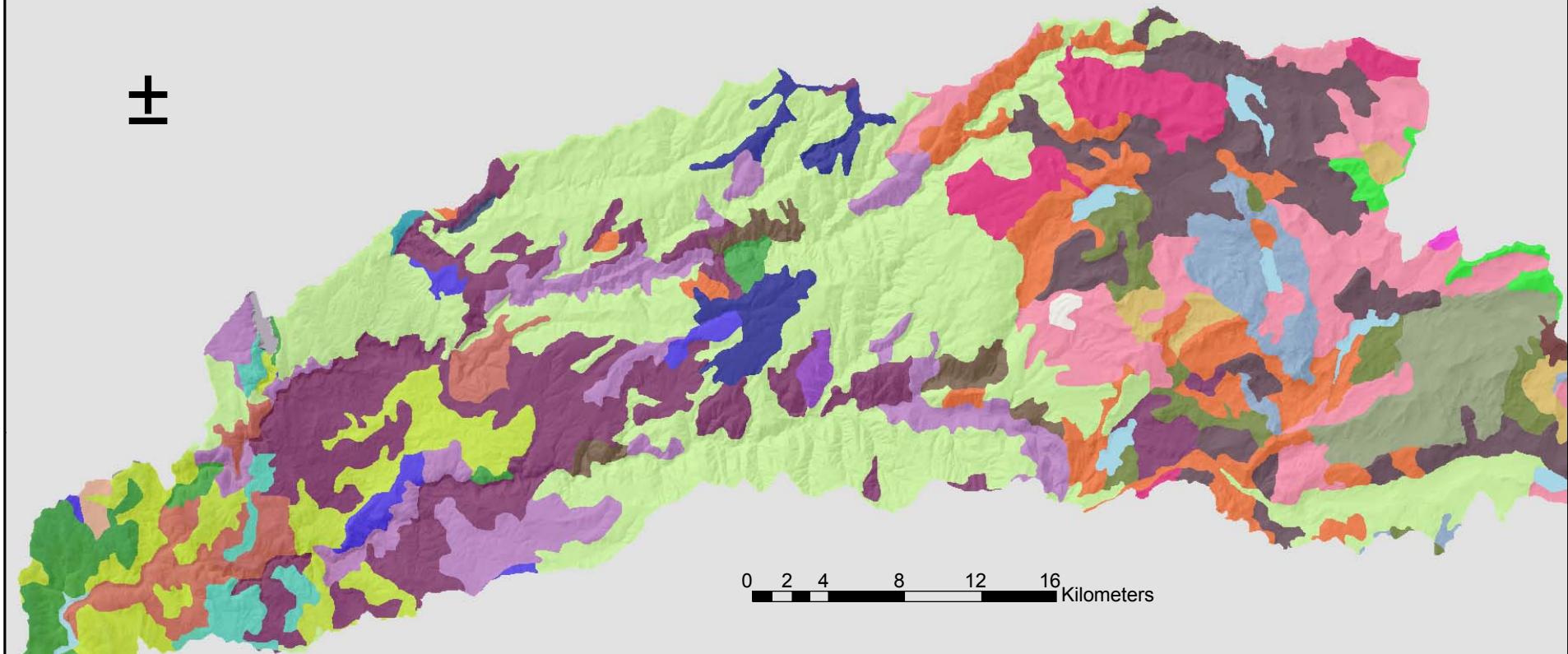
Calculated from particle size  
in STATSGO dataset

# Geology of Watershed



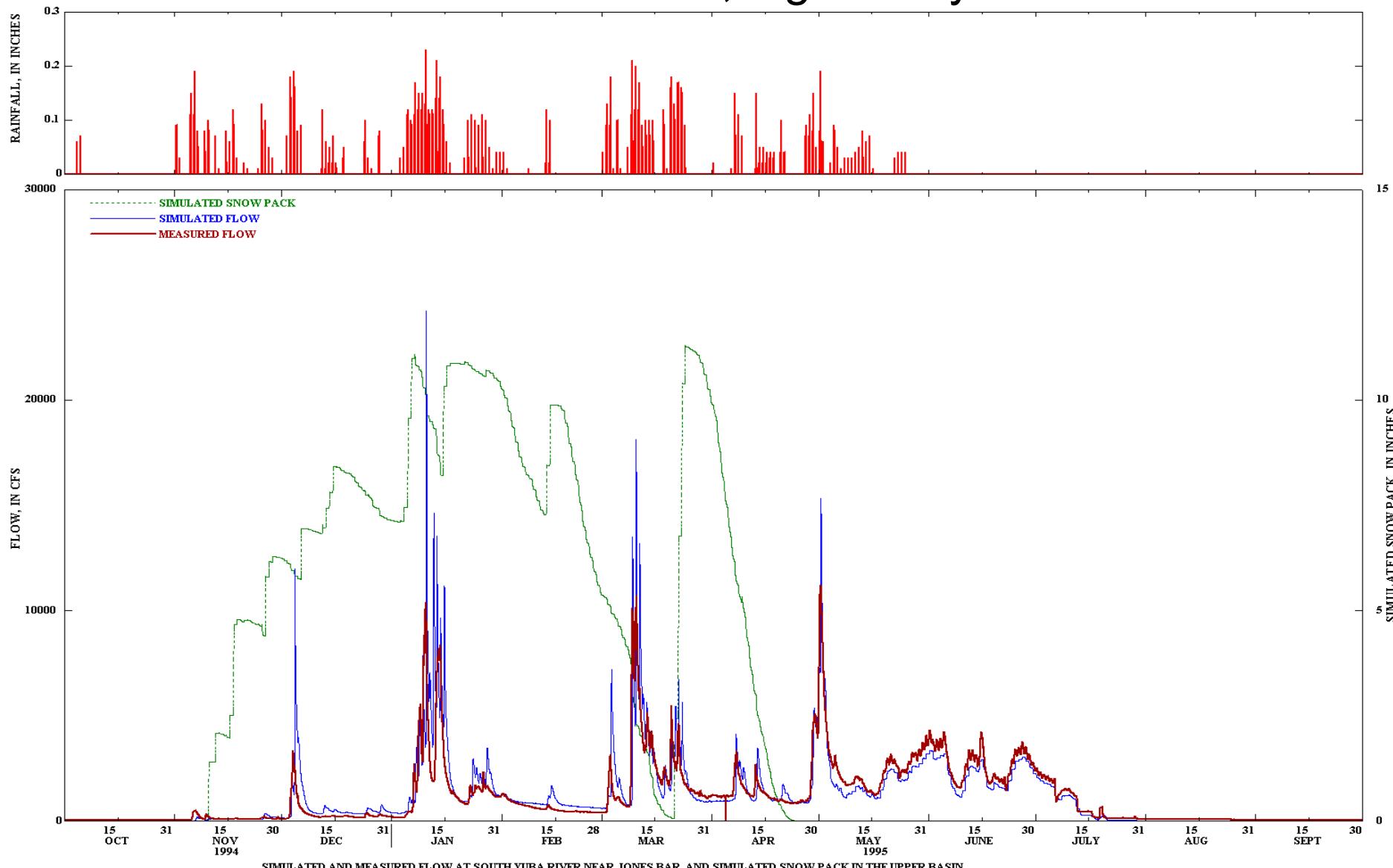
# Vegetation Type

±



Agriculture	Conifer Plantation	Non-Native Grassland	Sierran White Fir
Bare Rock	Huckleberry Oak	Orchard/Vineyard	Strip Mine/Quarry
Big Sagebrush	Interior Live Oak	Oregon Oak Woodland	Subalpine Sagebrush
Black Oak Forest	Jeffrey Pine	Pine Woodland	Tanoak Forest
Black Oak Woodland	Lake	Pine-Oak Woodland	Urban
Blue Oak Woodland	Lodgepole Pine	Red Fir-Western White Pine	Valley Oak Woodland
Bush Chinquapin	Mixed Montane Chaparral	Red Fir-White Fir	Westside Ponderosa Pine
Canyon Live Oak	Montane Meadow	Sierran Mixed Conifer	

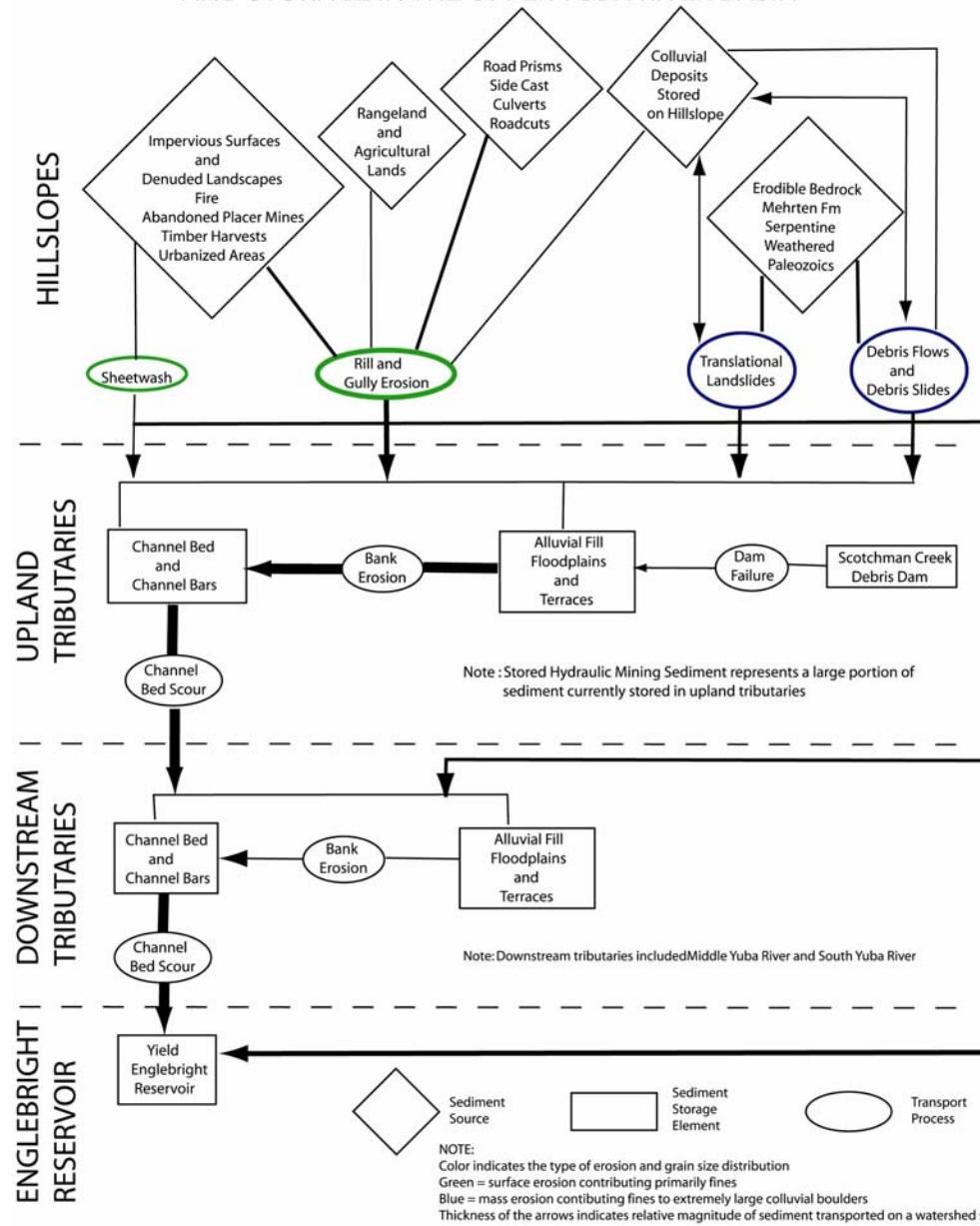
# Simulated and Measured 15-min Flow at Jones Bar 1995 Water Year, big snow year



# Sediment Processes

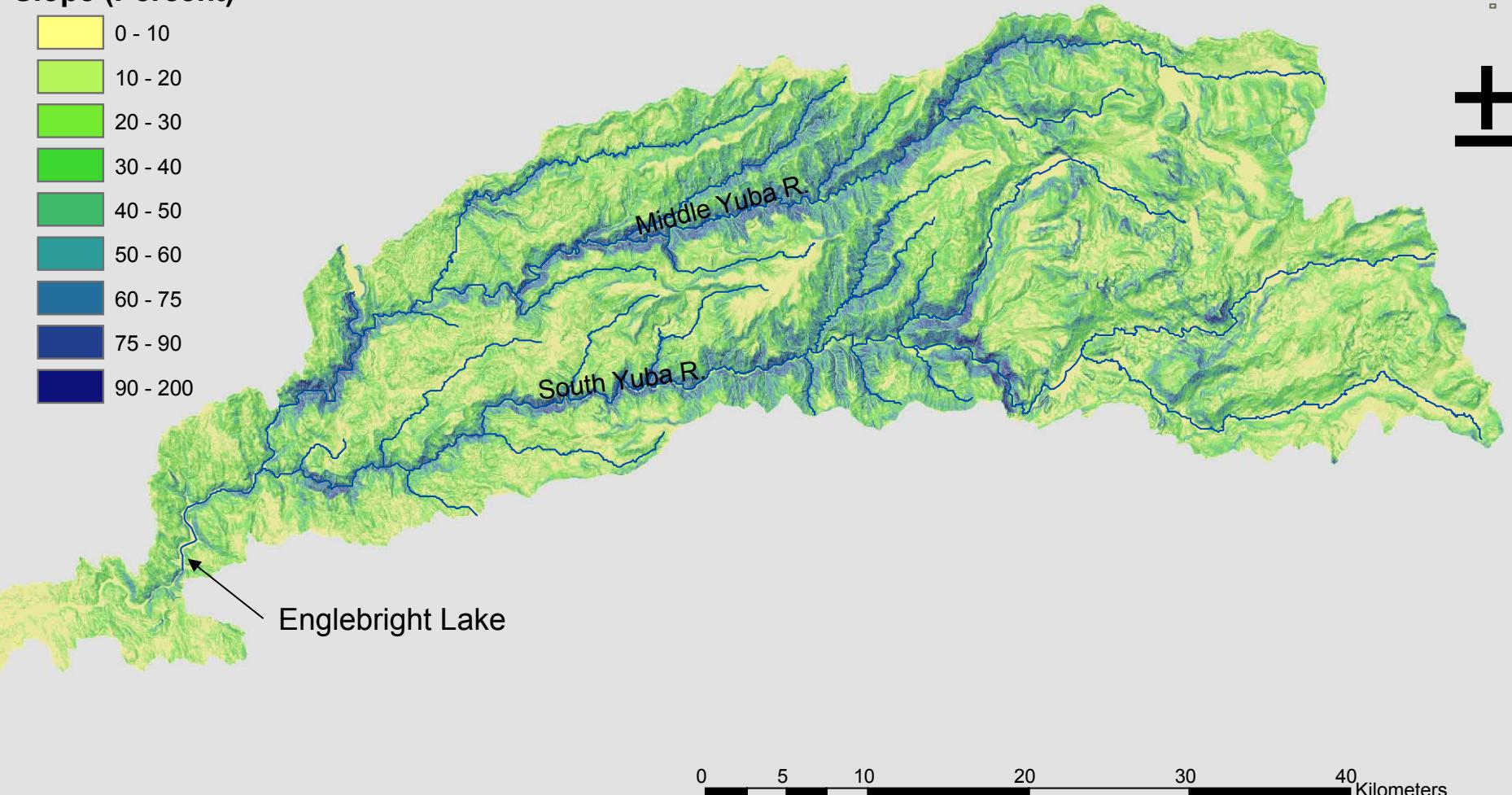
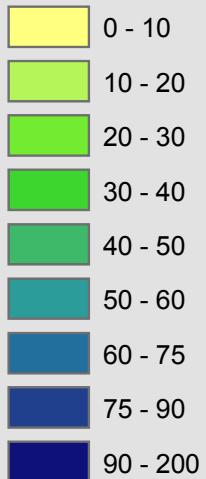
- Mass Erosion
- Surface Erosion
- Channel Processes
  - Stored Sediment
  - Suspended Sediment
  - Bedload Transport

# CONCEPTUAL MODEL OF SEDIMENT SUPPLY, TRANSPORT, AND STORAGE IN THE UPPER YUBA RIVER BASIN



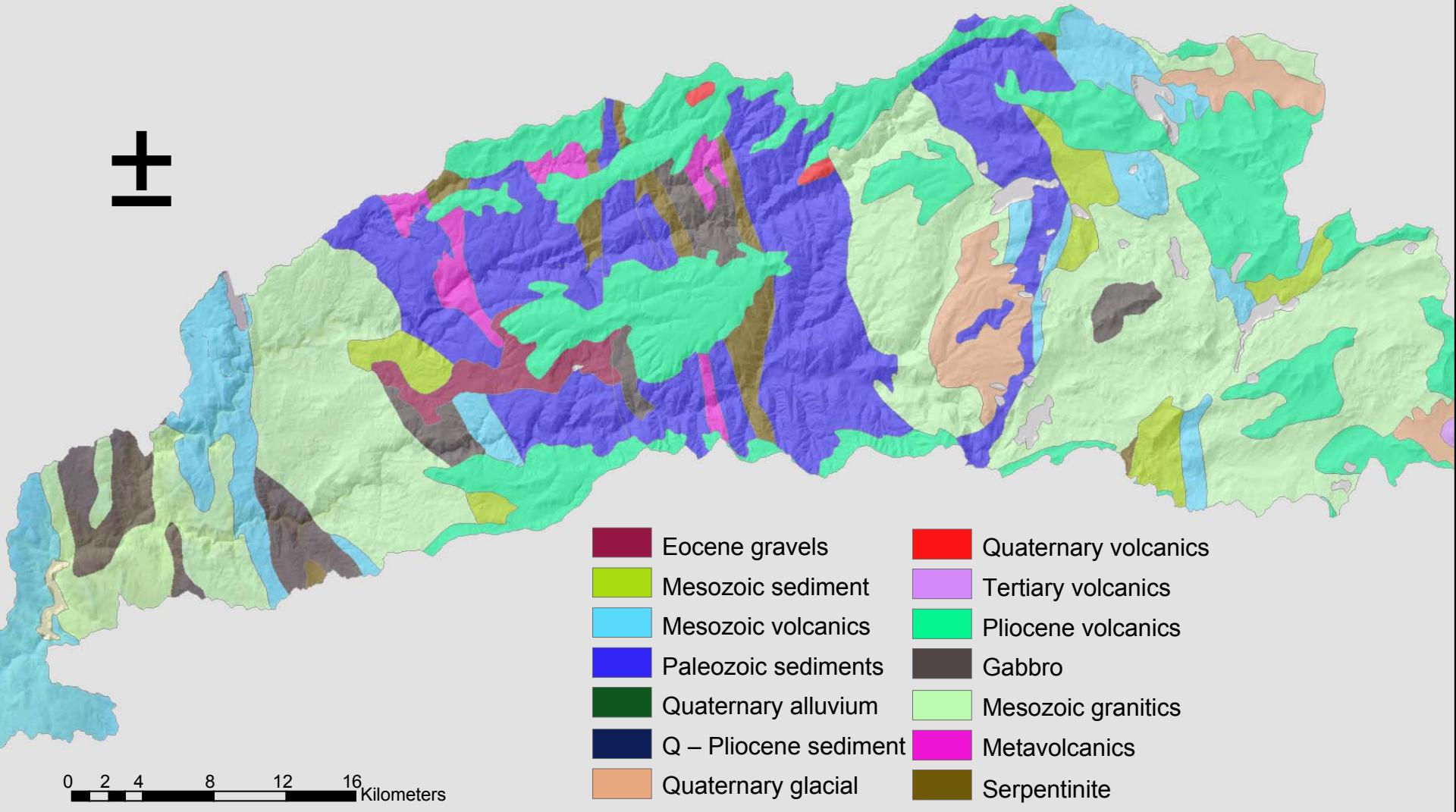
# Upper Yuba River Watershed

Slope (Percent)



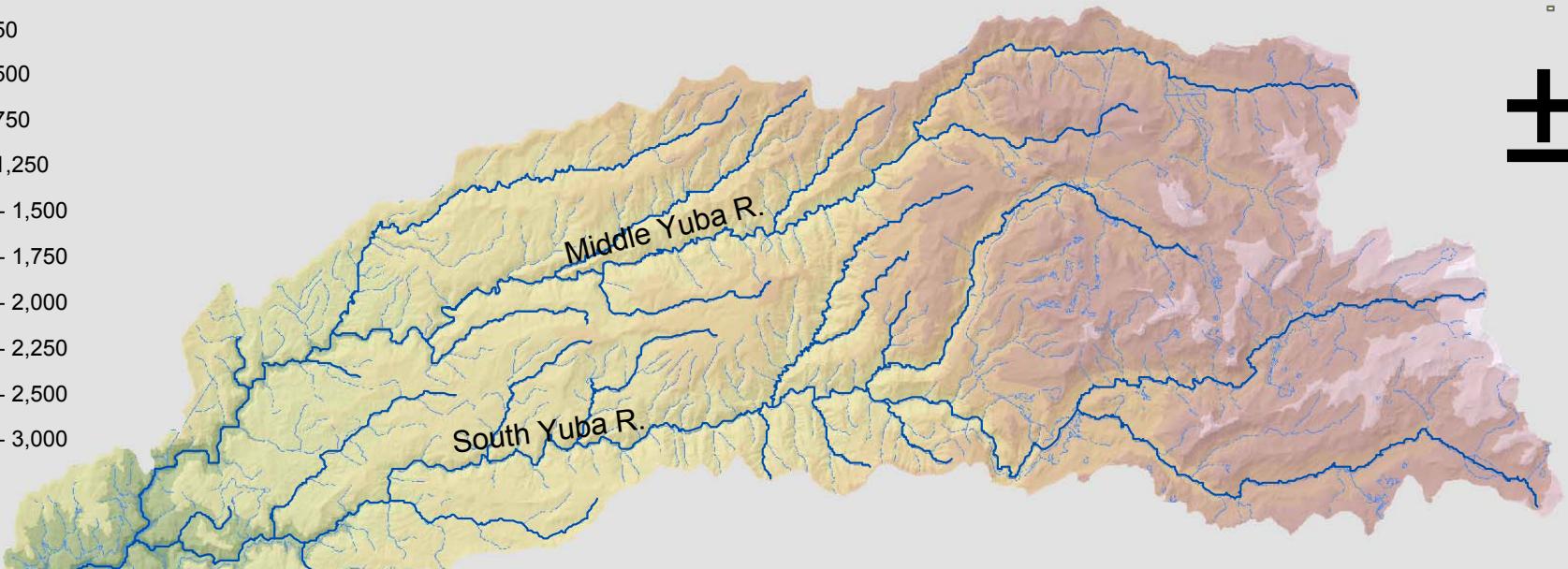
0 5 10 20 30 40 Kilometers

# Geology of Watershed



# Upper Yuba River Watershed

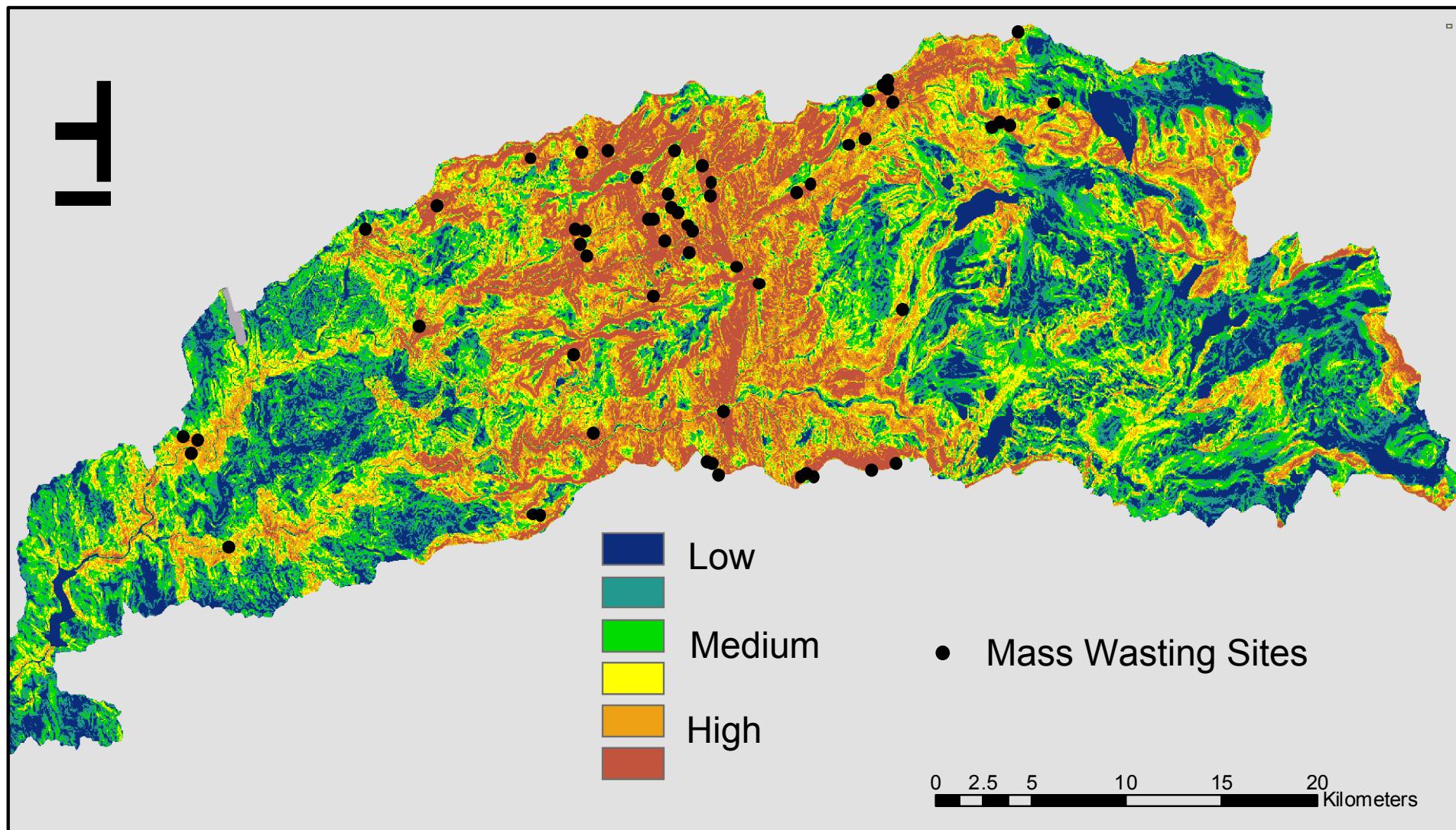
Elevation, m



Englebright Lake

0 5 10 20 30 40 Kilometers

# Mass Erosion Potential Map



- Slope ( $> 0.35$ ), Geology (Mehrtens, Serpentinite, and sheared metasediments),

- Elevation (rain on snow at 1200 to 1800 m)

# Summary Mass Erosion Data

- Thin soils and low weathering rates make debris slides the dominant mass erosion process
- Landslides and coalesced debris flows (amphitheater) contribute the largest volume of sediment per site
- Slope ( $> 0.35$ ) and geology (Mehrten Fm, serpentinized ultramafics, and weathered metasediments and granitic terrains) are the primary variables controlling the location of mass erosion

	Slope	% Delivered	Annual Delivery Rate (m <sup>3</sup> /yr)	Geology
Landslides	0.43	40	1570	M, Serp
Debris Slides	0.58	60	174	M, Serp, Gr
Rock Slides	0.62	85	280	Pz, Serp, Gr
Debris Flows	0.70	70	4865	M

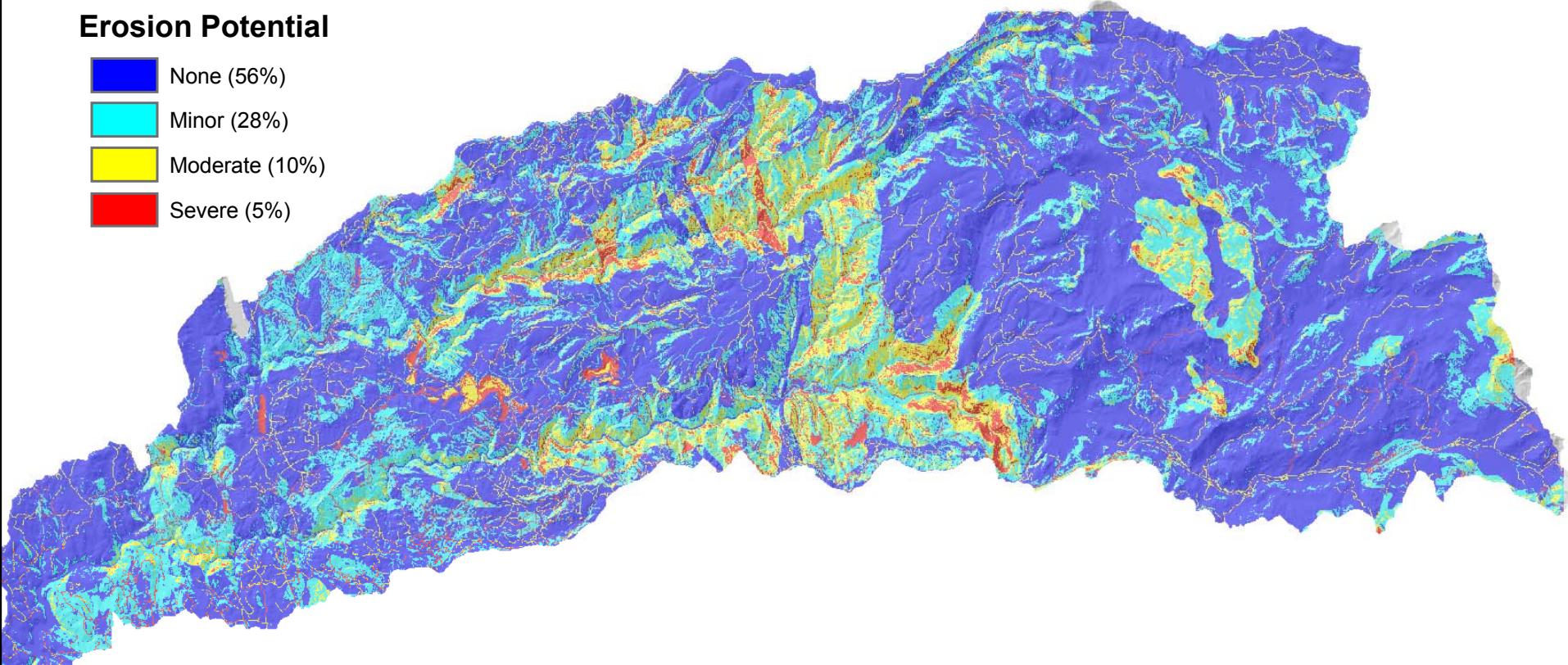
## Numerous Factors Influence Surface Erosion

- Roads and roads crossing streams
  - road-building boom of the 1950s through 1970s “the greatest disturbance of the Sierra Nevada landscape since the gold rush”
- Soil type, structure, and erodability
- Soil saturation
- Steep slopes
- Lack of stabilizing roots: low vegetation density
- Rainfall intensity (impact and runoff volume)
- Denuded landscapes such as hydraulic placer mines, timber harvest areas, and burned areas

# Surface Erosion Potential Map

## Erosion Potential

- █ None (56%)
- █ Minor (28%)
- █ Moderate (10%)
- █ Severe (5%)

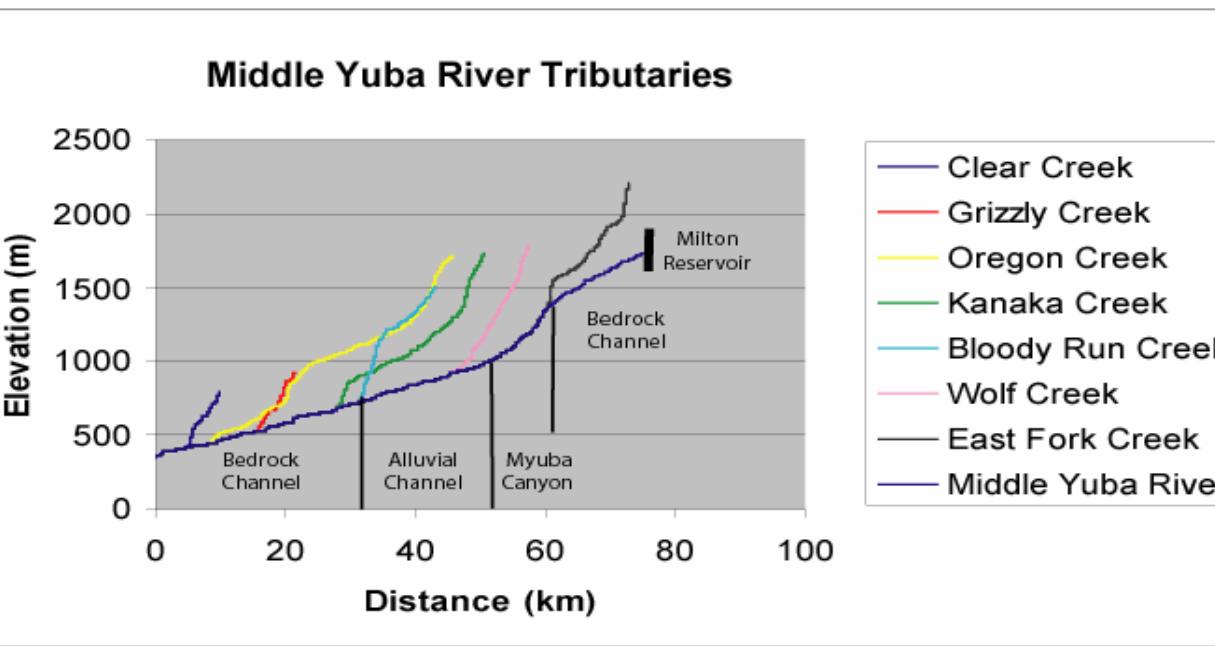
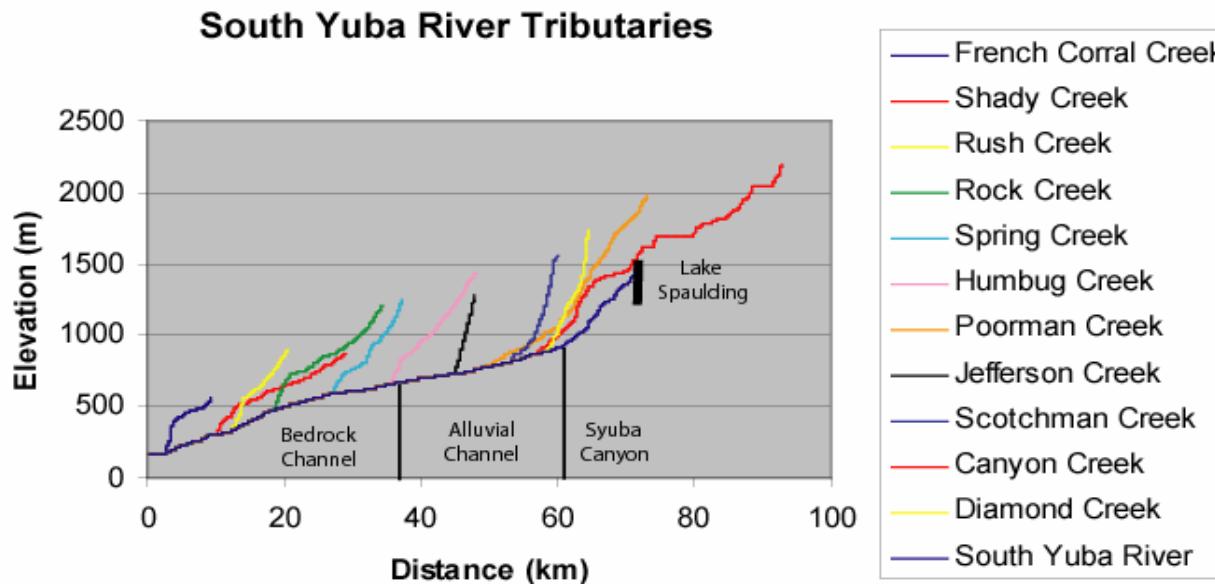


$[(\text{roads} + \text{mines} + \text{mass erosion sites} + \text{stream crossings}) * 10] + [(\text{geologic hazard} + \text{kfactor}) * 9] + [\text{slope} * 7] - [\text{April potential evapotranspiration} * 4] - [\text{vegcover} * 6]$

Geologic hazard = elevation (3 classes) \* slope \* geologic hazard index

All factors scaled to 1. Multipliers developed on the basis of field observations.

# Longitudinal Profiles of Upper Yuba Tributaries



# Channel Storage Inventory

- Volume of channel storage in 48 zero through fifth order channel reaches (length, width, height above 2002 thalweg)
- Storage elements include :
  - Debris Jams (0 – 50%)
    - LWD creates storage site
  - Channel Bars (5-30%)
    - alternate, mid-channel, and point bars
  - Floodplains (0 – 20%)
    - low relief surfaces adjacent to channel that are inundated periodically
  - Terraces (60 – 90 %)
    - abandoned floodplains
  - Scotchman Creek Debris Dam = 140,000 m<sup>3</sup>

# Legend

- Channel Storage Sites



# Channel Storage Summary

Strahler Stream Order	Average Slope (m/m)	Average Storage Values (m <sup>3</sup> /m)	Hydraulic mining and glacial reaches (m <sup>3</sup> /m)	Study Area Channel Length (km)	Basin-wide Sediment Storage (m <sup>3</sup> x 10 <sup>6</sup> )
Zero	<b>0.18</b>	<b>0.17</b>	--	<b>1345</b>	<b>0.23</b>
First	<b>0.14</b>	<b>13</b>	--	<b>589</b>	<b>7.8</b>
Second	<b>0.09</b>	<b>6.3</b>	<b>378</b>	<b>276</b>	<b>1.7</b>
Third	<b>0.07</b>	<b>15</b>	<b>676</b>	<b>153</b>	<b>2.3</b>
Fourth	<b>0.04</b>	<b>70</b>	<b>560</b>	<b>117</b>	<b>4.2</b>
Fifth <sup>1</sup>	<b>0.02</b>	<b>348</b>	<b>2920</b>	<b>134</b>	<b>482</b>
TOTAL				<b>2614</b>	<b>500</b>

<sup>1</sup> Fifth order basins include the Myuba and Syuba

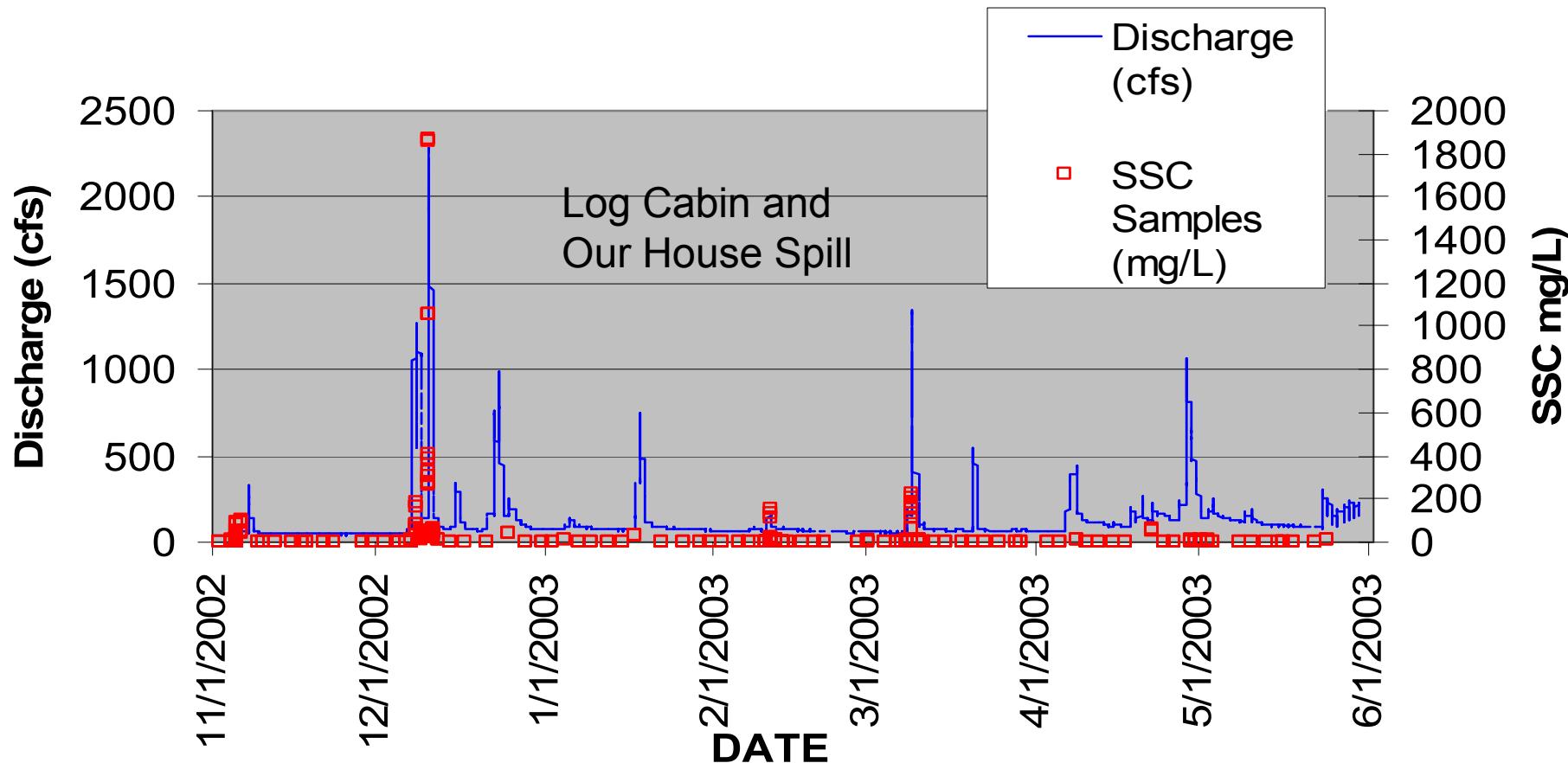
## Legend

- Daily sediment and discharge gages



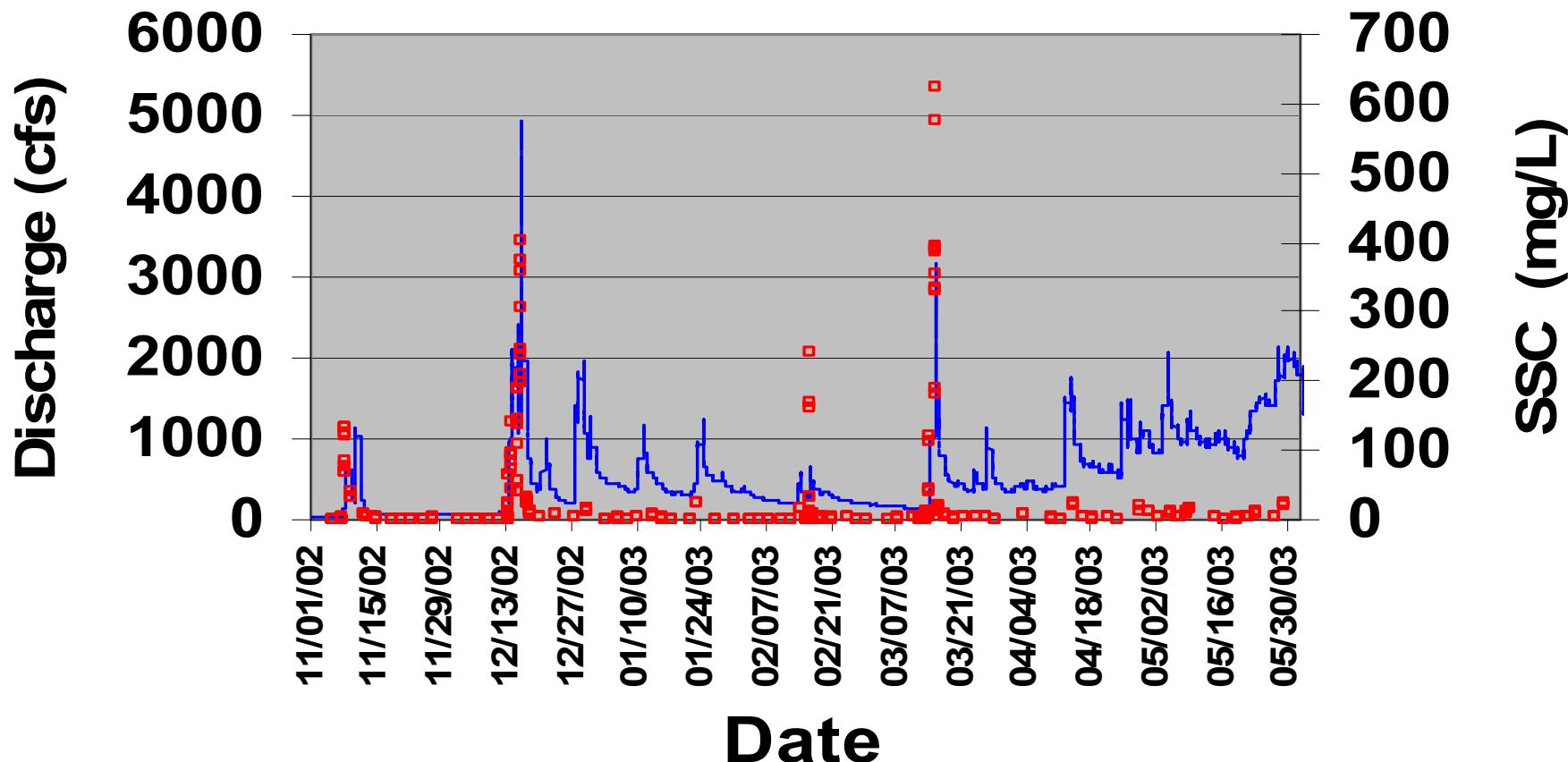
# 2003 Discharge and Suspended Sediment

**Myuba 11410000**



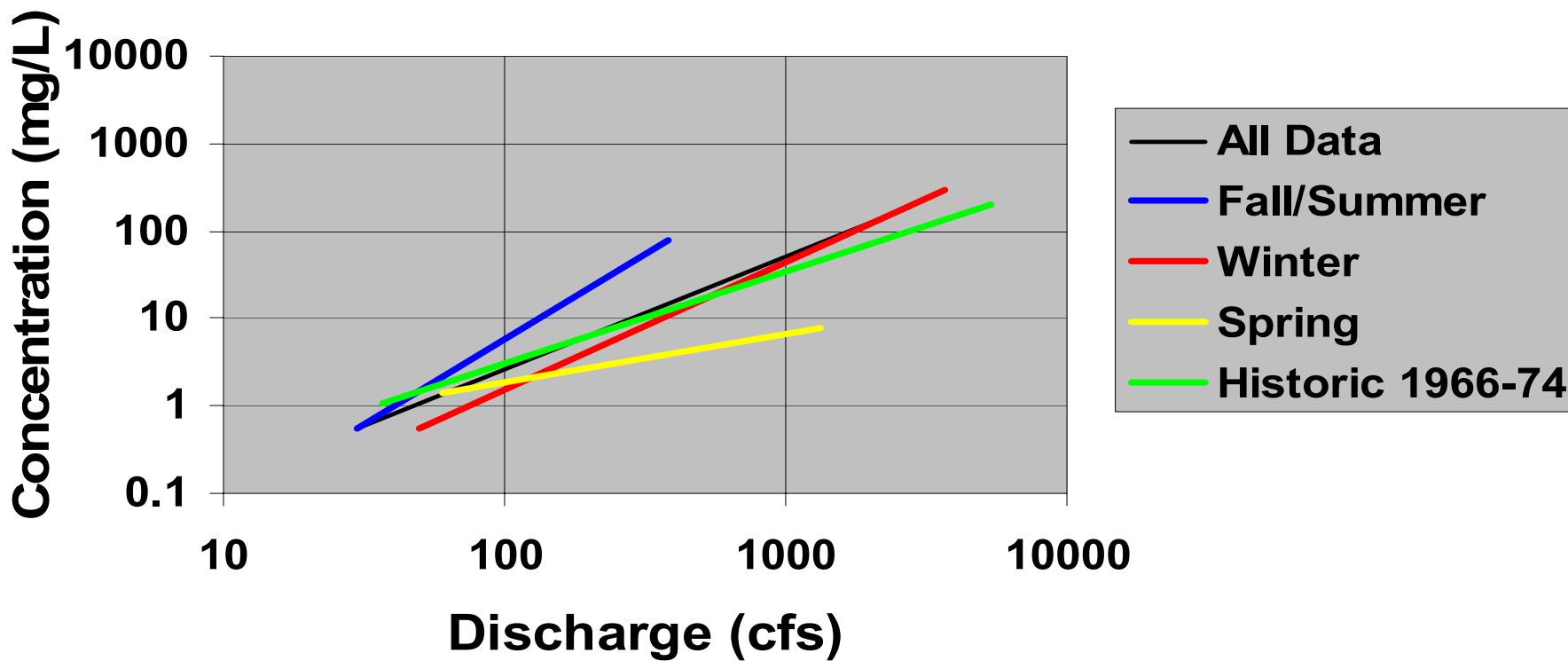
# 2003 Discharge and Suspended Sediment

**SYuba 11417500**



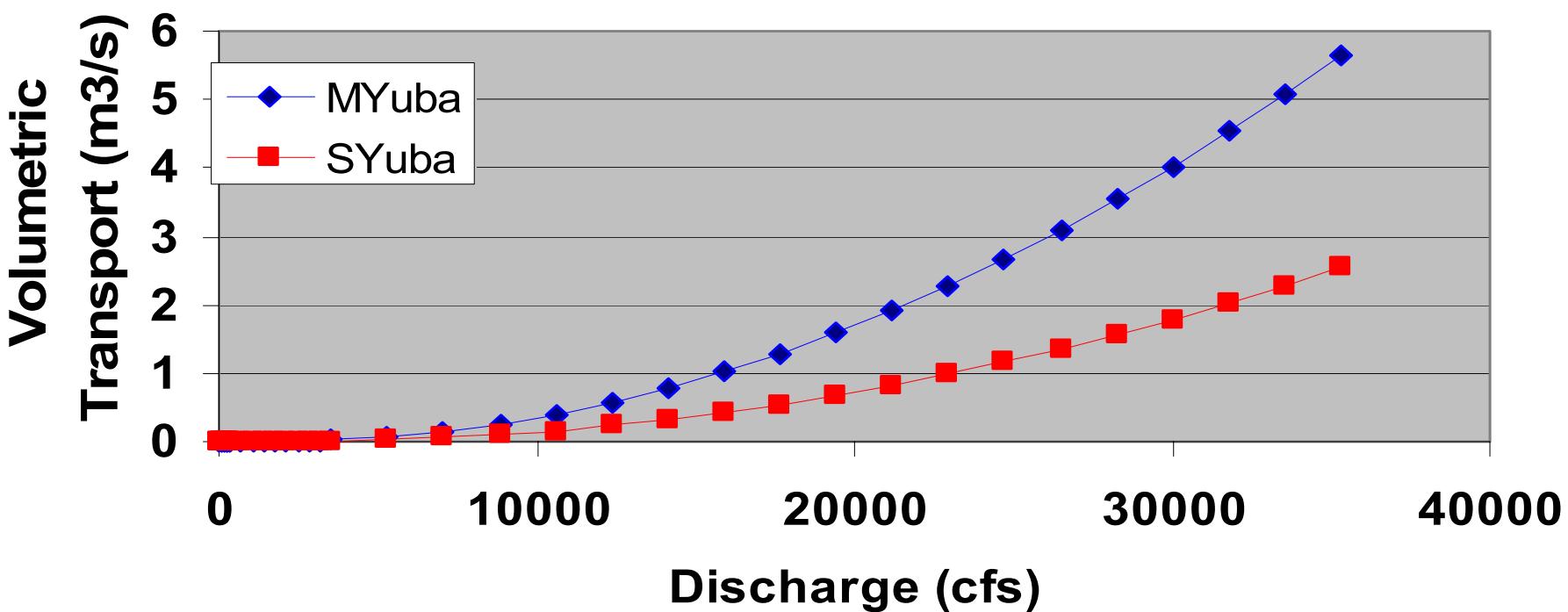
# WY 01 – 03 Discharge and Suspended Sediment

**Syuba 11417500**



# Bedload Transport

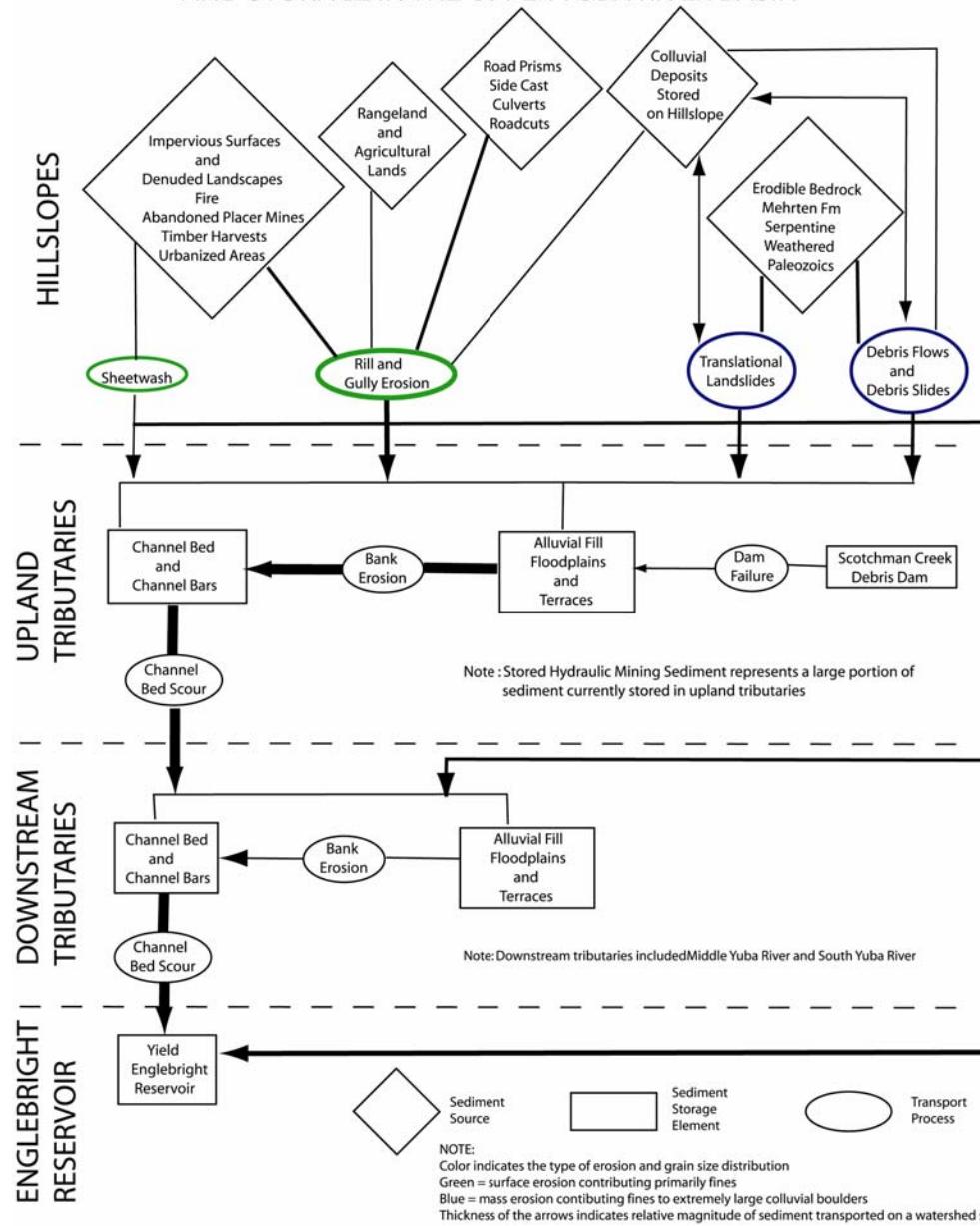
Bedload Rating Curves  
Hopkins Surface Based Model for  
Mixed-Sized Sediment (Wilcock, 2003)



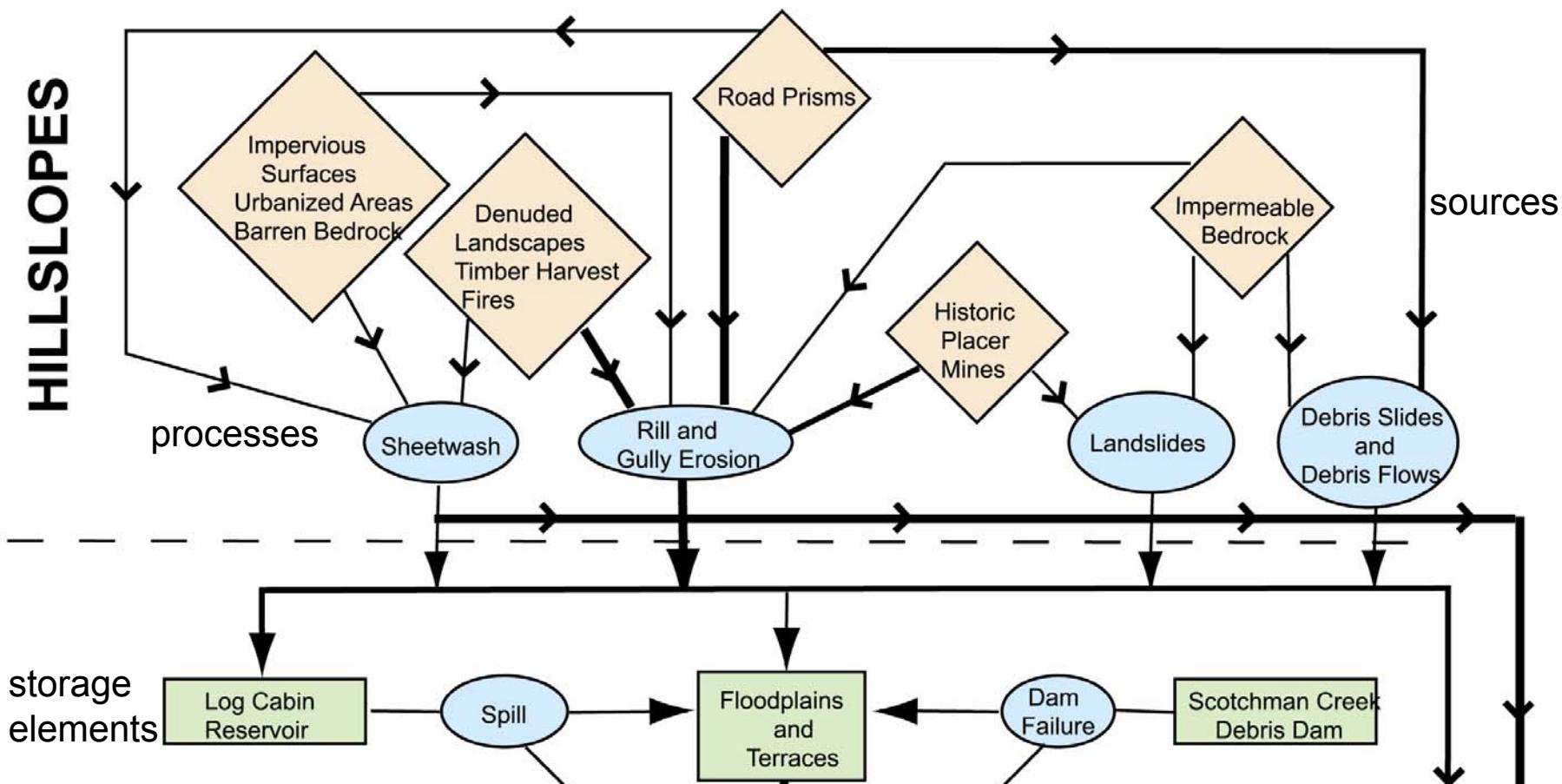
# Annual Sediment Loads

	2001 Annual Sediment Yield (tons)	2002 Annual Sediment Yield (tons)	2003 Annual Sediment Yield (tons)
Myuba			
Bed Load	0.01	3.36	19.05
Suspended Load	142	482	2,414
Syuba			
Bed Load	0.50	16.29	88.46
Suspended Load	1,510	3,357	7,672
TOTAL	1,652	3,859	10,193
Colgate	2,100	2,700	na
Englebright	1,400	3,600	6310

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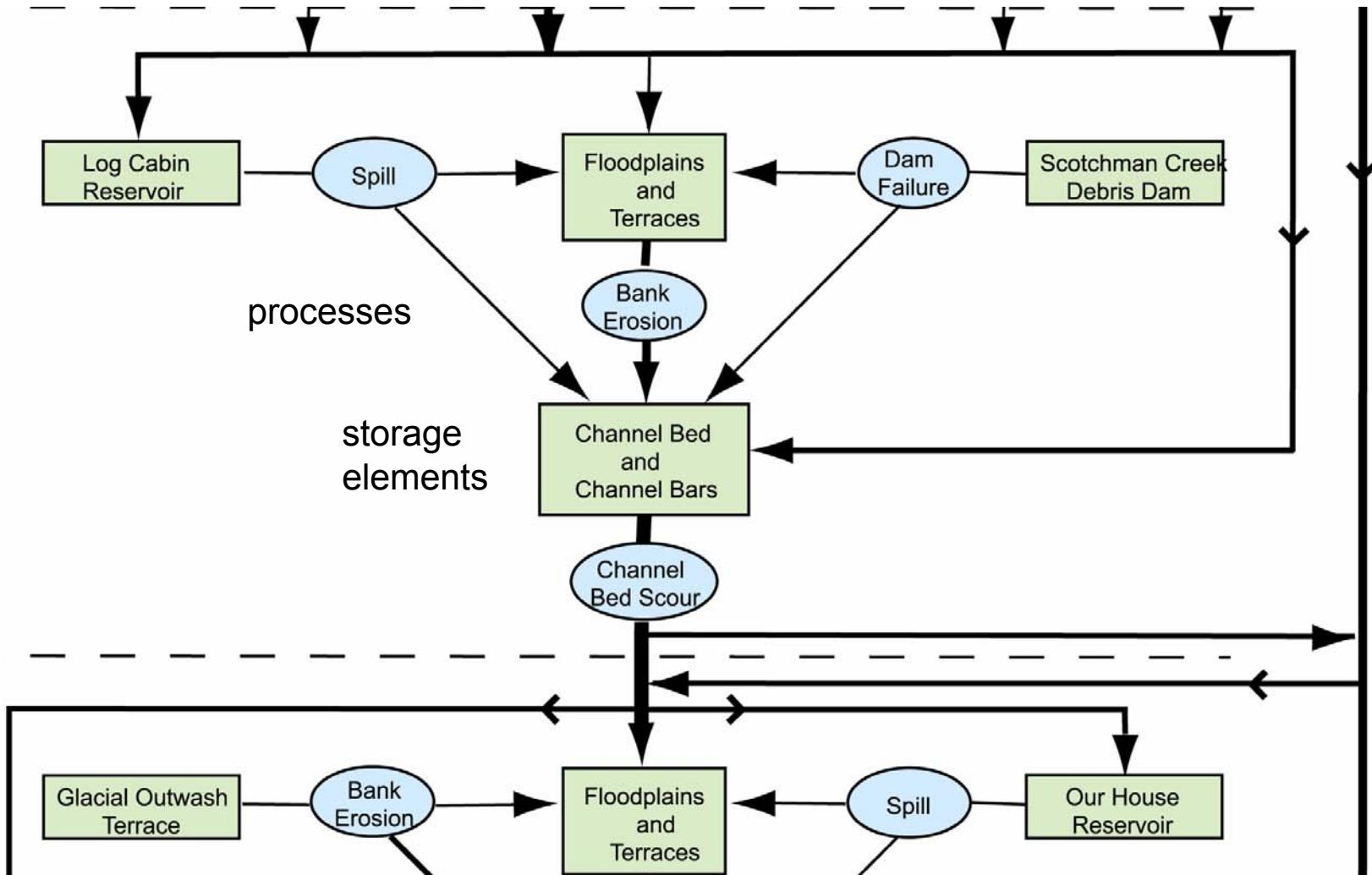


# Conceptual Model of Hillslope Sediment Processes



# Conceptual Model of Sediment Processes Upland Tributaries

## UPLAND TRIBUTARIES



# Conceptual Model of Sediment Processes Downstream Tributaries

DOWNTSTREAM  
TRIBUTARIES

